Oblique Collisions MS (From OCR 4730)

Q1, (Jun 2006, Q5)

	M1		Σmv conserved in **i** direction.
$2x12\cos60^\circ - 3x8 = 2a + 3b$	A1		
	M1		For using NEL
For LHS of equation below	A1		
$0.5(12\cos60^\circ + 8) = b - a$	A1		Complete equation with signs of a and b consistent with previous equation.
	M1		For eliminating a or b.
Speed of B is $0.4ms^{-1}$ in **i** direction	A1		
$a = -6.6$	A1		
Component of A's velocity in **j** direction is $12\sin60^\circ$	B1		May be shown on diagram or implied in subsequent work.
Speed of A is $12.3ms^{-1}$	B1ft		
	M1		For using $\theta = \tan^{-1}$(**j**comp/$\pm$ **i** comp)
Direction is at 122.4° to the **i** direction	A1ft	1 2	Accept $\theta = 57.6^\circ$ with θ correctly identified.

Q2, (Jan 2007, Q6)

(i) $[u\sin30^\circ = 3]$	M1		For momentum equation for B, normal to line of centres
$u = 6$	A1	2	
(ii) $[4\sin88.1^\circ = v\sin45^\circ]$	M1		For momentum equation for A, normal to line of centres
$v = 5.65$	A1		
	M1		For momentum equation along line of centres
$0.4(4\cos88.1^\circ) - mu\cos30^\circ = -0.4v\cos45^\circ$	A1		
$m = 0.318$	A1	5	
(iii)	M1		For using NEL
$0.75(4\cos\theta + u\cos30^\circ) = v\cos45^\circ$	A1		
$4\sin\theta = v\sin45^\circ$	B1		
$[3\cos\theta + 4.5\cos30^\circ = 4\sin\theta]$	M1		For eliminating v
$8\sin\theta - 6\cos\theta = 9\cos30^\circ$	A1	5	AG

Q3, (Jun 2007, Q4)

$y = 15\sin\alpha$ $(=12)$	B1		
$[4(15\cos\alpha) - 3 \times 12 = 4a + 3b]$	M1		For using principle of conservation of momentum in the direction of l.o.c.
Equation complete with not more than one error	A1		
$4a + 3b = 0$	A1		
	M1		For using NEL in the direction of l.o.c.
$0.5(15\cos\alpha + 12) = b - a$	A1		
$[a = -4.5, b = 6]$	M1		For solving for a and b
[Speed = $\sqrt{(-4.5)^2 + 12^2}$, Direction $\tan^{-1}(12/(-4.50))$]	M1		For correct method for speed or direction of A
Speed of A is $12.8ms^{-1}$ and direction is 111° anticlockwise from '**i**' direction	A1		Direction may be stated in any form , including $\theta = 69^\circ$ with θ clearly and appropriately indicated
Speed of B is $6ms^{-1}$ to the right	A1	10	Depends on first three M marks

Q4, (Jan 2009, Q5)

Initial **i** components of velocity for A and B are $4ms^{-1}$ and $3ms^{-1}$ respectively.	B1	May be implied.
	M1	For using p.c.mmtm. parallel to l.o.c.
$3x4 + 4x3 = 3a + 4b$	A1	
	M1	For using NEL
$0.75(4 - 3) = b - a$	A1	
	M1	For attempting to find a
$a = 3$	A1	Depends on all three M marks
Final **j** component of velocity for A is $3ms^{-1}$	B1	May be implied
	M1	For using $\tan^{-1}(v_j/v_i)$ for A
Angle with l.o.c. is 45° or 135°	A1ft	ft incorrect value of a ($\neq 0$) only
	[10]	
		SR for consistent sin/cos mix (max 8/10)
		$3x3 + 4x4 = 3a + 4b$ and
		$b - a = 0.75(3 - 4)$
		M1 M1 as scheme and A1 for *both* equ's
		$a = 4$ M1 as scheme A1
		j component for A is $4ms^{-1}$ B1
		Angle $\tan^{-1}(4/4) = 45^\circ$ M1 as scheme A1

Q5, (Jan 2010, Q2)

	M1	For using the principle of conservation of momentum
$2a + 3b = 2\times4$	A1	
	M1	For using NEL
$b - a = 0.6\times4$	A1	
$[2(b - 2.4) + 3b = 8]$	M1	For eliminating a
$b = 2.56$	A1	
$v = 2.56$	B1ft	ft $v = b$
	[7]	

Q6, (Jun 2012, Q6)

(i)	$\frac{1}{2} \times 2(5^2 - v^2) = 7.56$ $(v^2 = 17.44)$ Speed is 4.18 ms^{-1}	M1 A1 A1 **[3]**	For using $\frac{1}{2}\, m(u^2 - v^2) = 7.56$ and solving for v; *must use '5', allow sign error/ missing ½, missing m.* Do not award if this is not candidate's final answer.
(ii)	$v_{Ay} = u_{Ay} = 5\sin\alpha = 4$ $[v_{Ax}{}^2 + 4^2 = 17.44 \rightarrow v_{Ax}{}^2 = 1.44]$ $v_{Ax} = \pm 1.2$ and v_{Ax} must be less than 0.8 ➔Component has magnitude 1.2 ms^{-1} and direction to the left	B1 M1 A1 **[3]**	 For using $v_{Ax}{}^2 + v_{Ay}{}^2 = 17.44$
(iii)	$2 \times 3 - m \times 2 = 2 \times (-1.2) + m \times 0.8$ $m = 3$	M1 A1 FT A1 **[3]**	For using the pcm parallel to loc must use 5cosα, 2, 0.8 and '1.2', 4 terms or equivalent, allow sign errors, condone one mass missing FT incorrect v_{AX} CAO
(iv)	$[e(3 + 2) = (1.2 + 0.8)]$ $e = 0.4$	M1 A1 **[2]**	For using NEL with their '1.2' and 5cosα, 2 and 0.8; allow sign errors. Must be right way up

Q7, (Jun 2014, Q3)

(i)	Using conservation of momentum along loc 0.1 x 2.8 + 0.4 x 1x0.8 = 0.4 x b Using NEL $b - 0 = -e(1x0.8 - 2.8)$ $e = 0.75$	M1 A1 M1 A1 A1 **[5]**	3 (or 4) terms, correct dimensions Vel diff after = e x vel diff before	Allow sign errors, (sin/cos) may see $b = 1.5$ Allow ± e
(ii)	$b(perp) = 0.6$ $\tan\beta = \frac{b(perp)}{\text{their } 1.5}$, angle turned through is $36.9° - \beta$ $= 15.1°$ (0.262 rad)	B1 M1* *M1 A1 **[4]**	 $\beta = 21.8°$; ft 1.5 from (i) Must be $36.9°$ − their β (soi)	May be on diagram 21.8014...(0.381 rad) 36.86989 15.068 scB1 for 165° after B1M1

Q8, (Jun 2015, Q5)

(i)	use of conservation of momentum $2ma\cos\alpha - mb\cos\beta = m\text{x}2\text{x}\cos 45°$ use of NEL $2\cos 45° - 0 = -2/3\ (-b\cos\beta - a\cos\alpha)$ attempt to eliminate $a\cos\alpha$ or $b\cos\beta$ $a\cos\alpha = 5\sqrt{2}/6$ $b\cos\beta = 2\sqrt{2}/3$ oe	M1* A1 M1* A1 *M1 A1 A1 **[7]**	must be 3 non-zero terms must be 3 non-zero terms, and 'e' in correct postion dep both previous M1 marks **AG** dep final M1 and www	allow sign errors, $m/2m$ errors, sin/cos allow sign errors, sin/cos,
(ii)	$a\sin\alpha = 2$ attempt to solve $a\sin\alpha = 2$ and $a\cos\alpha = 5\sqrt{2}/6$ $a = 2.32$ $\alpha = 59.5°$	B1 M1 A1 A1 **[4]**	need to eliminate a or α accept 1.03 radians	 2.321398..., 59.49104...°, 1.0383...rad

Q9, (Jun 2016, Q3)

(i)	C of M $2m \times 5\cos\alpha - 3m \times 3\frac{1}{4}\cos\beta = 2ma + 3mb$ $2m\text{x}4 - 3m\text{x}1.25 = 2ma + 3mb$ Newton's experimental law $b - a = -\frac{2}{3}(-1.25 - 4)$ Attempt to solve simultaneous equations $b = 2.25$ (m s^{-1}) ($a = -1.25$ so) speed of $A = 3.25$ (m s^{-1})	M1* A1 M1* A1 *M1 A1 A1 **7**	allow sign and number slips. ($2a + 3b = 4.25$) Or equivalent; allow sign slips ($b - a = 3.5$) CAO CAO	a and b are vels of A and B to right Consistent −2.25 if b defined to left
(ii)	A and B both have same component of velocity perp to l o c After collision with wall B must move faster than A Coeff of restitution > 5/9 (accept > 0.5 recurring, or 0.556)	B1 B1 B1 **3**	 May be implied Do not allow ≥	 Ignore $e \leq 1$, etc